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A New Anuran Amphibian from the Pliocene of Kansas

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(Plates XLII-XLV)

ABSTRACT: *Scaphiopus studeri* sp. nov. is described from the Middle Pliocene of Logan county, Kansas. It is compared in detail with *Scaphiopus bombifrons* Cope, a modern species of the genus.

DURING the summer of 1936 a fossil frog was presented to Mr. Claude Hibbard for the Museum of the University of Kansas by Mr. Frank Studer. The specimen had been obtained by Mr. Studer some time previously from a bed of diatomaceous marl located in Logan county (sec. 7, T. 11 S., R. 37 W.) about a mile east of the "Rhino Hill Quarry," which is near the east line of Wallace county.

This bed, some feet in thickness, of a gray-white color, has yielded a large number of fossil fresh-water fish, but so far as I know this is the first and only representative of any other vertebrate group that has been found.

The amphibian was obtained by cleaving a slab of marl. In doing this, portions of the skeleton remained on both sides of the slab. When first obtained the fossil was perfect, but its subsequent treatment has brought about the loss of certain of the bones, including important skull elements and the greater portion of the vertebrae. However, many of the bones are still intact and the bone impressions are relatively clear, save in the skull region.

The specimen is certainly referable to the family Scaphiopodidae, and because of its resemblance to certain modern forms I am proposing tentatively to place it in the genus *Scaphiopus*.

Scaphiopus studeri sp. nov.

Holotype. Univ. Kansas Museum of Paleontology No. 1478, consisting of a split slab of marl, each portion of which contains both imprints and bones of a single animal.

Type locality. Logan county, Kansas (sec. 7, T. 11 S., R. 37 W.), about a mile east of "Rhino Hill Quarry," near the Wallace county line.

Horizon. Diatomaceous marl, in contact with the Edson Beds, Middle Pliocene.

Diagnosis. A medium-sized *Scaphiopus* approaching the character of *Scaphiopus bombifrons* Cope more closely than any other living form; and related to *Scaphiopus pliobatrachus* Taylor, a fossil form. Spade large, tibiale and fibulare fused together at ends; sacral diapophyses fan-shaped, the sacral vertebra solidly fused to the urostyle; apparently a broad fontanelle between the frontoparietals. The ethmoid has a rounded knoblike termination. Total length, snout to vent, about 58 mm.; width of knees with limbs at right angles to body, 47 mm.

Description of the Holotype. [Photographs of the fossil remains are given (plates XLII and XLIII) and this is interpreted by a series of drawings of the individual elements (plates XLIV and XLV). I have compared these with the same elements in *Scaphiopus bombifrons* now occurring in Kansas. Some of the points of difference are worthy of note: 1st vertebra very different in size and general character; carpalia very different; tibiale and fibulare solidly fused (not so in *bombifrons*); distal ethmoid termination not bending down, but lying in general plane of the remainder of the bone. Since the various elements of the fossil and recent forms are figured side by side, other numerous differences may be discerned, and need not be discussed here.]

SKULL

The skull is in an extremely fragmentary condition. The ventral part of the braincase is broken away, leaving the frontoparietal elements showing with a large fontanelle between them. Anteriorly a part of the ethmoid remains. It is somewhat boxlike, its anterior part enclosed, presenting at its anterior end a knoblike termination. In the character of the frontoparietals and the condition of the ethmoid this species resembles *Scaphiopus bombifrons*. In the latter the anterior projection is deflected, while in the present specimen it is straight. The nasals, turbinals, and vomers are badly shattered and the few remaining fragments tell little of the former extent of the

bones, and their relationships. A triradial fragment of the pterygoid is present, in contact with the maxillary.

No traces of vomerine teeth are discernible on the one or two fragments which may represent portions of the vomers. (Plate XLIV, fig. 2.)

Maxillary. Portions of the maxillaries are present on both sides. On the left side is a fragment measuring 5.2 mm. along the labial edge; it contains 15 teeth with one or two missing tooth spaces; on the right side the maxillary consists of four fragments which lie in a straight line (rather than curving) and show 39 teeth or tooth spaces with a total length of 9.1 mm. The maxillary shelf is at right angles to the direction of the teeth with a very slight trough standing out about six eighths mm. from the bone. The impression of the posterior extension of the maxillary shows the total length to be 10 mm., the posterior part of the bone extending out from the shaft of the quadrato-jugal to which it attaches; the greatest width (vertical) of the maxillary (2.6 mm.) is near its most anterior point. (Plate XLIV, figs. 5 and 6.)

Premaxillary. A portion of one premaxillary is present, but it has been displaced backward out of line with the maxillaries. It bears 8 teeth and two spaces. The process is missing.

Frontoparietals. These are thickened elements with a clearly defined longitudinal fontanelle between them suggesting the condition obtaining in *Scaphiopus bombifrons*. Their depth in the matrix shows a skull with considerable depth as is typical of modern *Scaphiopus*.

Parasphenoid. This element is completely shattered and only one or two small fragments are present.

Ethmoid. This element is represented by its anterior end, which is boxlike, presenting anteriorly a knoblike boss quite unlike the proboscislike termination of this element in *S. bombifrons*. Other skull elements cannot be made out in their entirety, although I believe all were present when the specimen was first obtained, with the possible exception of the mandible. (Plate XLIV, figs. 12, 13.)

THE VERTEBRAL COLUMN

The vertebral column, having a total length to end of the urostyle of 35.2 mm., consists of 9 vertebrae, with the urostyle solidly fused to the ninth (sacral) vertebra. The diapophyses are strongly dilated, fan shaped. The vertebrae from the second to the ninth are so shattered that it is difficult to interpret all the characters from the fragments and the impressions.

It is impossible to determine, beyond peradventure, the characters of the centra; however, the impression left of the ventral surfaces of the vertebrae show the suture between them curved so as to suggest strongly that most of the vertebrae are procoelous.

The first vertebra is complete, and seen from below shows two curving emarginations on the anterior upper edge of the vertebra with a v-shaped median notch. The anterior sockets for the condyles are large, and the element is strongly widened anteriorly and narrowed suddenly posteriorly. This vertebra is opisthocoelous.

The transverse process of the second vertebra is directed slightly forward; it is not or but slightly widened. The third vertebra has a transverse process distinctly wider distally than proximally, strongly compressed vertically at its proximal end; on the fourth vertebra the process is wider at the base than distally, terminating in a more or less rounded tip directed almost directly outward; its length is 4.3 mm. The fifth and sixth processes are very short, 1.2-1.4 mm. in length.

The sacral vertebra has the ventral part of the centrum shattered and missing; however, most of the urostyle is present and the greatly widened processes of the sacral vertebra. These elements are fused together. The greatest transverse width of the sacral vertebra is 10 mm.; the greatest width of the transverse process 5 mm.; the length of vertebra and urostyle (estimated) 16.3 mm. The urostyle is compressed vertically and is rounded below; it is without any ventral crest. (Plate XLIV, fig. 4.)

THE PECTORAL GIRDLE

The pectoral girdle is represented by a few fragments and impressions. The coracoid is strongly bowed ventrally and at the same time tends to curve anteriorly; the clavicle is slender and a nearly complete impression is discernible. The median point of contact of the clavicles is at their extreme tips, and there is no suggestion of an overlapping. In the case of the coracoids I can make out the median end of neither. There is no evidence of a cartilage or bone posterior to the coracoid (omosternum), but there are some bone fragments just anterior which I cannot certainly interpret. (Plate XLV, fig. 12.)

Scapula. This is discernible only as a deep depression which shows the element narrowing typically near the middle of the bone, then curving out strongly. A proximal portion of the suprascapula is present and the outline of the complete bone is shown by the impression left by the remaining part. The proximal half of the element is rectangular, but the distal part narrow and the anterior edge

of the complete element is distinctly curved, rather like the condition in modern *Scaphiopus bombifrons*.

ARM

Humerus. The humeri are more or less broken, but where broken the imprint is clear enough to show the following measurements: Total length, 16 mm. and 15.8 mm.; greatest width, 4.6 mm. and 4.8 mm.; diameter of the ball at distal end, 2.3 mm.; each of these elements has a compressed ridge or crest on its anterior half, which extends nearly two thirds the length of the bone. The diameter of the proximal head of the humerus is 3 mm. (Plate XLV, fig. 13.)

Radio-ulna. This element is now missing save for a few fragments. The impression shows a bone 10.5 mm. long (right side), 10.2 mm. (left side); each 3.5 mm. wide at the distal end.

At the distal end of the ulnar part is an epiphysis separately ossified. (It appears to be the cartilagenous element present in modern *Scaphiopus* usually so conspicuous because of its pure white color.) (Plate XLV, fig. 9.)

Carpalia. For the position of these elements, refer to the drawings. There are eight or nine of these, including the distal elements of the prepollex. The ulnare of the left hand seen from the dorsal surface is somewhat compressed. Its exposed dorsal surface shows a median groove with two ridges bordering it; the centrale is more than double the size of the ulnare, its outer face a curving surface. On the dorsal surface there is a slight depression, roughly the shape of an hour glass. The radiale is apparently missing save for a small portion of the element which presents a rounded convex surface which fits into a similar socket in the preceding carpal element. Apparently a small carpal is lost from the proximal end of the first finger; below this apparently missing element is a very tiny element imbedded in the matrix. The prepollex bone is 1.8 mm. long, and 1.15 mm. wide at the base. It narrows rapidly to a rounded point, curving slightly. (Plate XLV, figs. 3, 11.)

Measurements of metacarpals and phalanges (right). (Plate XLV, Fig. 3.)

	Meta- carpal.	First phalanx.	Second phalanx.	Third phalanx.
First finger	5	0.5	0.5
Second finger	4.3	1.5	0.5
Third finger	4.9	2.2	1.2	0.5
Fourth finger	4	1.1	0.85	0.5

THE PELVIC GIRDLE

Ilium. A portion of the ilium is present on both sides. On the right side the widened acetabular part is broken just anterior to the acetabular depression. The total length of this element is 23 millimeters to the middle of the acetabulum (estimated from the impression). At the acetabular end the bone widens. There is no knob or projecting elevation of the dorsal posterior part. The anterior ends of the ilia reach and fuse with the sacral vertebra, but do not extend to the anterior edge of the widened processes. (Plate XLIV, figs. 8, 10.)

Ischia. The right and left ischia are closely fused, and where they join with the ilium they form an elevation, when these elements are seen in profile.

Pubis. This element seems to have been at least partially of soft cartilage, for there is a discontinuity of the ventral outline of the pelvis in lateral view; no trace of a suture can be discerned to suggest fusion with ischium. It may have been normally missing or not ossified. The edges of the acetabular cup are raised on both the ischium and ilium.

Hind limb. Both hind limbs are present and all of the bones are likewise present on one or the other. The larger, thicker parts are more or less shattered. On both sides the feet are folded so as to show their ventral surfaces.

Femur. The left femur has the acetabular head complete. The greatest diameter of the head is about 2.2 mm.; the total length of the femur is 21 mm., and its greatest diameter 4.2 mm. at the distal end; it narrows to a width of 1.5 mm.; the posterior edge is slightly flattened, forming a crest (this portion is broken, but an impression of the crest can be discerned). Near the distal end is a thickened boss. (Plate XLV, fig. 2.)

Tibia-fibula. This element, somewhat broken at each end, has a total length of 18.2 mm. The arterial foramina on opposite sides of the shaft are distinct; that of the fibula one millimeter in advance of the other. No very marked grooves are visible between the fused elements, due to the shattering of portions of the exposed surface. The internal partition between the two elements is discernible at the proximal end where the bony surface is broken. (Plate XLV, fig. 10.)

Tibiale and Fibulare (astragalus and calcaneum). These two elements are present on the left side only. They are apparently completely fused together and are perfect save that a fragment is fractured from the inner distal end. It is still in place, however. The

distal width of the fused bones is 6 mm.; the proximal width, 4.6 mm.; near the proximal end of the fibulare, on its ventral surface, is a slight ridge from near the point of contact with the tibiale, to its outer edge, limiting a somewhat roughened triangular area on the ventrolateral surface. (Plate XLV, fig. 6.)

Tarsalia. Four tarsal elements, including the prehallux, are present—apparently representing the complete equipment. A small element is present at the proximal end of the first digit, and one at the proximal ends of the second and third equally in contact with both digits. The prehallux consists of an enlarged basal element from which arises a broad shovel-shaped element which originally was pressed against the ventral surface of the proximal phalanges of the first and second digits. Originally intact, this latter element has been broken, but the impression in the matrix can be seen.

The two small tarsalia (Nos. 1 and 2) are flattened, biscuit-shaped. The third may represent a fusion of two elements. The large spade (prehallux) had an original length of 4.3 mm. and a width (estimated) of about 3 mm. The sharp cutting edge (probably originally bearing horn) is evident. (Plate XLV, fig. 6.)

Metatarsals, phalanges. These elements for the most part or their clear impressions are present. Their measurements in millimeters from the first to fifth digits are given in a table.

Measurements of metatarsals and phalanges. (Plate XLV, Fig. 6.)

	Meta-tarsal.	First phalanx.	Second phalanx.	Third phalanx.
Right foot:				
First toe.....	5.6	1.7		
Second toe.....	8.1	2.3		
Third toe.....	10.1	3.6	1.7	
Fourth toe.....	11.5	5.2		
Fifth toe.....	9.3	3.6	2	0.6
Left foot:				
First toe.....	5.6	1.5		
Second toe.....	8.1	2.2		
Third toe.....	10.1	3.8	1.95	
Fourth toe.....	11.5	5.1	3	1.2
Fifth toe.....	9.3	3.8	2	0.6

The terminal elements vary in shape. That of the fifth toe is rather pyramidal with a slight cylindrical projection (slightly triangular in profile) from the distal end. That on the fourth finger is more curving, elongated and clawlike. The others are small, somewhat triangular, curving downward very slightly.

Remarks. The relationship of this form to *Scaphiopus plio-batrachus* Taylor from a nearby locality in the Edson Beds is discussed in a paper now in press and is not repeated here.



PLATE XLII

Scaphiopus studeri sp. nov. Type: Lower part of slab showing bones, with the exception of the feet, and tibia fibula from a dorsal view. Impressions are of the ventral surfaces of bones. Actual "head-body" length about 58 mm.



PLATE XLIII

Scaphiopus studei sp. nov. Type: Upper part of slab showing bones from their ventral surfaces, the impressions from the dorsal surface.

PLATE XLIV

FIG. 1. *Scaphiopus bombifrons*. Morton county, Kansas. Ventral view of skull.

FIG. 2. *Scaphiopus studeri* sp. nov. Type: Ventral view of skull.

FIG. 3. *Scaphiopus bombifrons*. Vertebral column.

FIG. 4. *Scaphiopus studeri* sp. nov. Vertebral column. Ventral view. Length, 35.2 mm.

FIGS. 5 and 6. *Scaphiopus studeri* sp. nov. Groups of teeth much enlarged.

FIG. 7. *Scaphiopus bombifrons*. Pelvic girdle.

FIG. 8. *Scaphiopus studeri* sp. nov. Pelvic girdle length, 25.2 mm.

FIG. 9. *Scaphiopus bombifrons*. Pelvic girdle, lateral view, 22.6 mm.

FIG. 10. *Scaphiopus studeri* sp. nov. Pelvic girdle, lateral view (the posterior fragment of the pelvis shown in Fig. 8 was destroyed accidentally before the drawing of Fig. 10 was made); (length, 23 mm.).

FIG. 11. *Scaphiopus bombifrons*. Front view of skull, showing the anterior part of the ethmoid deflected downward almost in contact with the premaxillary (much enlarged).

FIG. 12. *Scaphiopus studeri* sp. nov. Portion of ethmoid as it appears *in situ* (much enlarged).

FIG. 13. Same; from a front view of its anterior end corresponding to the position of ethmoid in Fig. 11, enlarged to same scale as Fig. 12.

FIG. 14. *Scaphiopus studeri* sp. nov. Impression of the radio-ulna. Actual size, 10.5 mm. long.

FIG. 15. *Scaphiopus bombifrons*. Radio-ulna, actual size, 10 mm. long.

PLATE XLIV

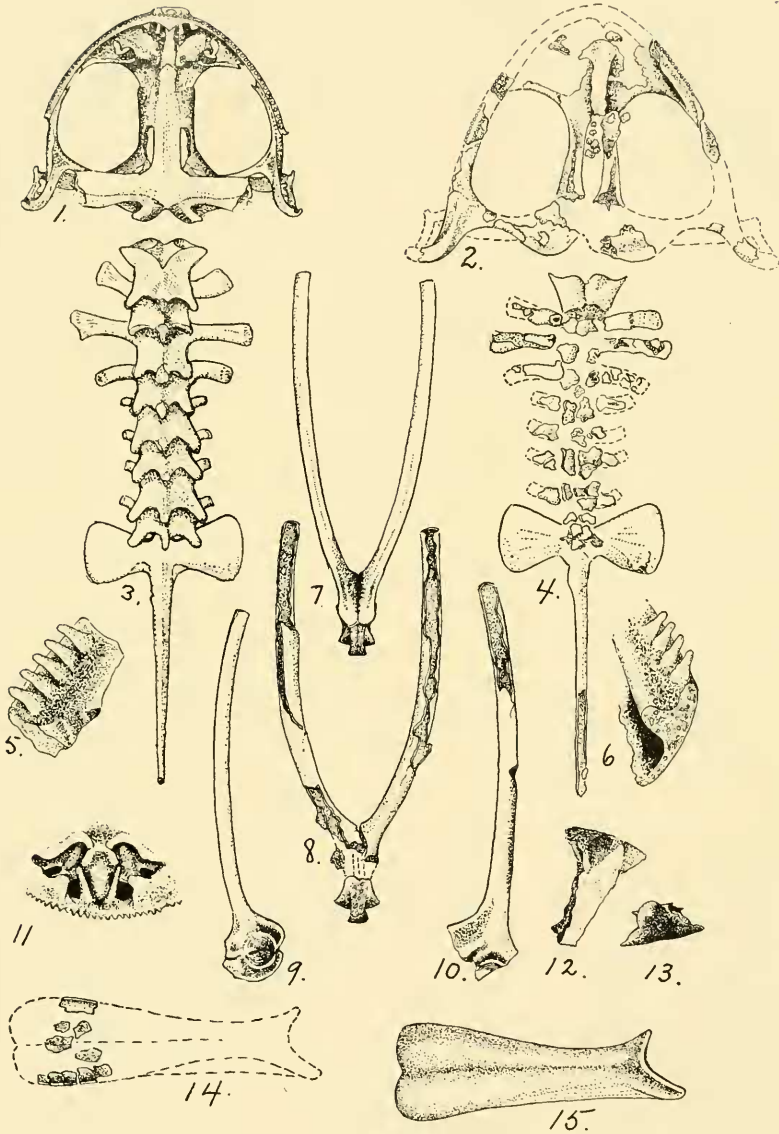


PLATE XLV

- FIG. 1. *Scaphiopus bombifrons*. Femur.
- FIG. 2. *Scaphiopus studeri* sp. nov. Femur (length, 21 mm.).
- FIG. 3. *Scaphiopus studeri* sp. nov. Hand.
- FIG. 4. *Scaphiopus bombifrons*. Hand.
- FIG. 5. *Scaphiopus bombifrons*. Foot.
- FIG. 6. *Scaphiopus studeri* sp. nov. Foot (length, 28 mm.).
- FIG. 7. *Scaphiopus bombifrons*. Pectoral girdle from dorsal view.
- FIG. 8. Same ventral view.
- FIG. 9. *Scaphiopus bombifrons*. Tibia-fibula.
- FIG. 10. *Scaphiopus studeri* sp. nov. Tibia-fibula (length, 18.2 mm.).
- FIG. 11. *Scaphiopus studeri* sp. nov. Carpalia (greatly enlarged).
- FIG. 12. *Scaphiopus studeri* sp. nov. Upper, bone, clavicle; lower, coracoid.
- FIG. 13. *Scaphiopus studeri* sp. nov. Humerus (actual length, 16 mm.).
- FIG. 14. *Scaphiopus bombifrons*. Humerus.

PLATE XLV

